

WHAT IS CLAIMED IS:

1. An optical transceiver for use with an optical plug disposed at one end of an optical fiber, comprising:
  - an optical socket to mount the optical plug;
  - a light-condensing device;
  - an optical element to perform at least one of emitting light in accordance with a supplied electrical signal, and generating an electrical signal in accordance with a received light signal; and
  - a light-transmissive substrate to support the optical socket, the light-condensing device, and the optical element so that the optical fiber, the light-condensing device, and the optical element are aligned on an optical axis of the optical transceiver.
2. An optical transceiver for use with an optical plug that holds one end of a first optical fiber and one end of a second optical fiber, comprising:
  - an optical socket to mount the optical plug;
  - first and second light-condensing devices;
  - a light emitter to emit light in accordance with a supplied electrical signal;
  - a light receiver to generate an electrical signal in accordance with a received light signal; and
  - a light-transmissive substrate to support the optical socket, the first and second light-condensing devices, the light emitter, and the light receiver so that the first optical fiber, the first light-condensing device, and the light emitter are aligned on a first optical axis of the optical transceiver and so that the second optical fiber, the second light-condensing device, and the light receiver are aligned on a second optical axis of the optical transceiver.
3. The optical transceiver according to Claim 1, the optical element being disposed on one surface of the substrate, and the light-condensing device and the optical socket being disposed on the other surface of the substrate in correspondence with the location of the optical element.
4. The optical transceiver according to Claim 2, the optical element being disposed on one surface of the substrate and the optical socket being disposed on the other surface of the substrate in correspondence with the location of the optical element, and a plurality of the light-condensing devices being used, with one of the light-condensing devices being disposed on the other surface of the substrate in correspondence with the location of the optical element and another light-condensing device being disposed near an end of the optical socket so as to oppose the optical element.

5. The optical transceiver according to Claim 2, the light emitter and the light receiver being disposed on one surface of the substrate, and the first and second light-condensing devices and the optical socket being disposed on the other surface of the substrate, with the first and second light-condensing devices being disposed on the other surface of the substrate in correspondence with the locations of the light emitter and the light receiver, respectively.

6. The optical transceiver according to Claim 2, the optical elements being disposed on one surface of the substrate and the optical socket being disposed on the other surface of the substrate in correspondence with the locations of the optical elements, and the first and second light-condensing devices being disposed so that one of the first and second light-condensing devices is disposed on the other surface of the substrate in correspondence with the location of one of the optical elements and the other of the first and second light-condensing devices is disposed near an end of the optical socket so as to oppose the one of the optical elements.

7. The optical transceiver according to Claim 1, the substrate being a glass substrate.

8. The optical transceiver according to Claim 1, the substrate having a plurality of guide holes, and the optical socket having a plurality of guide pins that are disposed in the respective guide holes.

9. The optical transceiver according to Claim 1, the optical socket being joined to the substrate.

10. The optical transceiver according to Claim 1, the light-condensing device being any one of a refractive lens, a Fresnel lens, and a Selfoc lens.

11. The optical transceiver according to Claim 1, at least one of the optical element and the light emitter being a surface emitting laser.

12. A method of producing an optical transceiver, comprising:  
forming a wiring film, serving as a wiring pattern, on one surface of a light-transmissive substrate;

joining an optical element having at least one of a light-emitting and a light-receiving function to a predetermined location of the wiring film;

disposing a lens on the other surface of the substrate; and  
mounting an optical socket to the other surface of the substrate, with the optical socket being used to mount an optical plug that holds one end of an optical fiber.

13. A method of producing an optical transceiver, comprising:

forming a wiring layer, serving as a wiring pattern, on one surface of a light-transmissive substrate;

joining an optical element having at least one of a light-emitting and a light-receiving function to a predetermined location of the wiring film; and

mounting an optical socket incorporating a lens to the other surface of the substrate, with the optical socket being used to mount an optical plug that holds one end of an optical fiber.

14. A method of producing an optical transceiver, comprising:

forming a guide hole in a predetermined location of a light-transmissive substrate;

forming a wiring film, serving as a wiring pattern, on one surface of the substrate by positioning the wiring film so that the wiring film is aligned with the guide hole;

connecting an optical element to the wiring film by positioning the optical element with respect to the other surface of the substrate with the guide hole as a reference;

mounting a lens to the other surface of the substrate by positioning the lens with respect to the other surface of the substrate with the guide hole as a reference; and

positioning an optical socket with respect to and mounting the optical socket to the substrate by inserting a guide pin of the optical socket into the guide hole from the other surface of the substrate, the optical socket being used to mount an optical plug that holds one end of an optical fiber.

15. A method of producing an optical transceiver, comprising:

forming a guide hole in a predetermined location of a light-transmissive substrate;

forming a wiring film, serving as a wiring pattern, on one surface of the substrate by positioning the wiring film so that the wiring film is aligned with the guide hole;

connecting an optical element to the wiring film by positioning the optical element with respect to the other surface of the substrate with the guide hole as a reference;

positioning the optical socket incorporating a lens with respect to and mounting the optical socket to the substrate by inserting a guide pin of the optical socket into the guide hole from the other surface of the substrate, the optical socket being used to mount an optical plug that holds one end of an optical fiber.

16. The method of producing an optical transceiver according to Claim 14, further including forming a plurality of the guide holes in the substrate, and forming a plurality of the guide pins in the optical socket.

17. The method of producing an optical transceiver according to Claim 12, further including supporting the one end of the optical fiber by a cylindrical ferrule disposed in the central portion of the optical plug, and inserting the ferrule into a sleeve of the optical socket, the sleeve having a cylindrical fitting hole, and the lens being disposed at the bottom portion of the fitting hole.

18. A method of producing an optical transceiver, comprising:  
forming a plurality of wiring films, serving as unit wiring patterns, on one surface of a substrate;

disposing a plurality of optical elements on the one surface of the substrate in correspondence with the locations of the plurality of unit wiring patterns;

disposing a plurality of lenses on the other surface of the substrate in correspondence with the locations of the optical elements;

mounting a plurality of optical sockets to the other surface of the substrate in correspondence with respective pairs of the optical elements and the lenses, each optical socket having a fitting hole to mount an optical plug that holds one end of an optical fiber; and

cutting the substrate into areas including the respective unit wiring patterns.

19. A method of producing an optical transceiver, comprising:  
forming a plurality of wiring films, serving as unit wiring patterns, on one surface of a substrate;

disposing a plurality of optical elements on the one surface of the substrate in correspondence with the locations of the plurality of unit wiring patterns;

mounting a plurality of optical sockets incorporating respective lenses to the other surface of the substrate in correspondence with respective pairs of the optical elements and the lenses, each optical socket having a fitting hole for mounting an optical plug that holds one end of an optical fiber; and

cutting the substrate into areas including the respective unit wiring patterns.

20. The method of producing an optical transceiver according to Claim 18, the mounting the optical sockets including securing the optical sockets to the substrate after adjusting the positions of the optical sockets so that the centers of the corresponding holes are disposed on optical axes connecting the corresponding optical elements and the corresponding lenses.

21. The method of producing an optical transceiver according to Claim 18, the disposing the lenses including forming the lenses at the same time by resin molding using a lens-shaped die.

22. The method of producing an optical transceiver according to Claim 18, the disposing the lenses including forming the lenses by adhering a liquid hardening resinous material to the substrate, by forming a surface of the resinous material into a substantially spherical surface by surface tension of the resinous material, and hardening the resinous material.

23. The method of producing an optical transceiver according to Claim 18, the cutting including placing the substrate on a cutting stage to fit sleeves of the optical sockets therein.

24. The method of producing an optical transceiver according to Claim 18, the cutting including scribing a line on a surface of the substrate along an intended cutting line and dividing the substrate into the areas including the respective unit wiring patterns by cutting the substrate along the scribe line.

25. The method of producing an optical transceiver according to Claim 18, the cutting including dividing the substrate into the areas including the respective unit wiring patterns by cutting the substrate as a result of forming an initial crack in a cutting starting point of the substrate and increasing the size of the initial crack along an intended cutting line by making use of thermal stress that has been generated by irradiation using a laser beam.

26. The method of producing an optical transceiver according to Claim 25, the dividing including branching a laser beam with which the substrate is irradiated into a first beam and a second beam by a diffraction grating, forming the initial crack by irradiation with the first beam, and increasing the size of the initial crack along the intended cutting line by making use of thermal stress that is generated by irradiation with the second beam.

27. The method of producing an optical transceiver according to Claim 18, the cutting including forming an altered layer by multiphoton absorption in the substrate along an intended cutting line of the substrate as a result of focusing a laser beam in the substrate and irradiating the substrate with the laser beam.

28. A method of producing an optical transceiver, comprising:  
forming a plurality of wiring films, serving as unit wiring patterns, on one surface of a substrate;  
disposing a plurality of optical elements on the one surface of the substrate in correspondence with the locations of the plurality of unit wiring patterns;

disposing a plurality of lenses on the other surface of the substrate in correspondence with the locations of the optical elements;

forming a low rigidity area along an intended cutting line of the substrate after the disposing of the optical elements or the disposing of the lenses;

mounting a plurality of optical sockets to the other surface of the substrate in correspondence with respective pairs of the optical elements and the lenses, each optical socket having a hole to mount an optical plug that holds one end of an optical fiber; and

cutting the substrate along the low rigidity area into areas including the respective unit wiring patterns.

29. A method for producing an optical transceiver, comprising:

forming a plurality of wiring films, serving as unit wiring patterns, on one surface of a substrate;

disposing a plurality of optical elements on the one surface of the substrate in correspondence with the locations of the plurality of unit wiring patterns;

forming a low rigidity area along an intended cutting line of the substrate;

mounting a plurality of optical sockets incorporating respective lenses to the other surface of the substrate in correspondence with respective pairs of the optical elements and the lenses, each optical socket having a fitting hole for mounting an optical plug that holds one end of an optical fiber; and

cutting the substrate along the low rigidity area into areas including the respective unit wiring patterns.

30. The method of producing an optical transceiver according to Claim 28, the forming a low rigidity area including scribing a line on a surface of the substrate using a hard material.

31. The method of producing an optical transceiver according to Claim 28, the forming a low rigidity area including forming an initial crack in a cutting starting point on the substrate and increasing the size of the initial crack along the intended cutting line by making use of thermal stress that has been produced by irradiating the initial crack using a laser beam, and immediately cooling an area where the laser beam has just passed in order to prevent the substrate from being completely cut.

32. The method of producing an optical transceiver according to Claim 28, the forming a low rigidity area including forming an altered layer by multiphoton absorption in the substrate along the intended cutting line of the substrate by focusing a laser beam in the substrate and irradiating the substrate with the laser beam.

33. A method of producing an optical connector substrate, comprising:  
temporarily mounting a substrate and an optical socket with hardening resin,  
the optical socket having a fitting hole that exposes a portion of the substrate;  
forming a portion of the hardening resin that is in the fitting hole into the  
shape of a lens by gathering the portion of the hardening resin at a portion, situated at the  
bottom portion of the fitting hole, of the substrate by inserting a lens die into the fitting hole  
of the optical socket;  
securing the optical socket to the substrate by hardening the hardening resin;  
forming a lens by hardening the portion of the hardening resin gathered at the  
substrate; and  
pulling out the lens die from the optical socket.

34. The method of producing an optical connector substrate according to Claim  
33, the fitting hole being also a guide groove to guide a mounting operation of an optical plug  
that supports one end of an optical fiber.

35. The method of producing an optical connector substrate according to Claim  
33, the hardening resin being a light-transmissive resin that is at least one of a photocurable  
resin and a thermosetting resin.